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COLLEGE OF ENGINEERING
Department of Civil Engineering
Transportation Institute

Final Report

A BACKGROUND PLANNING STUDY OF MICHIGAN'S AVIATION NEEDS

Part V. Summary of Conclusions and Recommendations

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INTRODUCTION

The constructive evolution of official aviation policy for Michigan and the rational development of state-wide airport plans require a more substantial factual basis than has existed in the past. To provide such a comprehensive guide for its work, the Michigan Department of Aeronautics initiated in 1958 this so-called "Background Planning Study of Michigan's Aviation Needs" by the Transportation Institute of The University of Michigan.

By extensive examination of records and accounts, by direct inquiry through interviews and correspondence, and by carefully prepared questionnaire-type surveys, the many segments comprising Michigan's aviation industry were studied, and the resulting statistics and information assembled. As these research efforts reached conclusive stages, detailed reports were prepared, to present the results and describe their derivation. These have been submitted under the following titles:

Part I. Aviation and the Economy of Michigan (June, 1960)

Part II. A Field Survey of Aviation and Airports in Selected Michigan Communities (August, 1960)

Part III. Growth and Technological Change in Aviation

Section 1. Technological Trends in Aircraft, Air Traffic and Traffic Control (August, 1960)

Section 2. Estimates of Growth in Michigan Aviation (January, 1961)

Part IV. Planning for Michigan Aviation (February, 1961)

Throughout these reports, numerous conclusions and some recommendations are developed and stated, either directly or by implication.

These are now drawn together in this summary to present a more nearly rational, though still subjective, concept of Michigan's aviation development over the next ten to fifteen years. Omitted, however, are the citations of the sources and references which are, it is believed, adequately indicated in the detailed reports.

Also omitted are estimates of costs of carrying out any of the proposed recommendations. Such cost determinations, if they are to be more than sheer guesses, required resources well beyond those available to the University for the study.

For convenience and consistency, this Summary is divided into four major sections which are presented in order: (A) Economic Aspects, (B) Technological Prospects, (C) Planning Approaches, and (D) A State-Wide Airport Plan.

This plan, it is to be emphasized, does not stipulate precise airport locations or specifications, nor is it intended as a rigid and final guide for Michigan's aviation development in the future. Rather, it is hoped that the plan can be carefully evaluated, modified as new and better information becomes available, and then adjusted to the specific local situations throughout the State. Perhaps, it can provide the stimulus for an enlarged State interest in achieving the more extensive system of airport facilities that will permit greater realization of aviation potentials in meeting Michigan's transportation needs.

A. Economic Aspects

In all transportation planning, economic considerations are a major influence. The nature and magnitude of the economic aspects of aviation in Michigan and its local communities have been described and displayed in detail in Parts I and II of the final report. From that text, several significant conclusions, recommendations, and items of information have been summarized.

1. Civil aviation is by far the most important in the development of policy and plans of the State. The inclusion of figures for military aviation—U.S. Air Force, Navy, Coast Guard, and Michigan Air National Guard—seriously distorts State statistics without providing any reliable guides which can be utilized in the civilian planning responsibilities of the Department of Aeronautics.

2. Civil aviation activities within Michigan make a substantial contribution to the State's economy. Presently available records, however, permit only a partial measurement of their value and prevent accurate compilation of comparative data in any continuing series.

3. An indication of the magnitude of civil aviation in Michigan in 1960 is provided by the following statistics:

Total Investment in Michigan Airports, ground facilities, Aircraft Equipment, excluding military.	\$240 million
Total Salaries and Wages for the estimated 5500 full-time equivalent employees in Michigan civil aviation.	\$ 23 million

Total Purchases of aircraft, fuel, supplies and parts, but excluding airport construc- tion, in Michigan.	\$ 22 million
Airport Construction and Maintenance	\$ 5 million
Total Expenditures by Michigan Aviation.	\$ 50 million
State and Local Taxes Paid directly by Aviation in Michigan	\$ 2 million

These figures are the result of conservative approximations and estimates of change from the extensive and detailed data for 1958-59 which was collected early in the study; sources and procedures are described, as previously noted, in Part I of the Final Report.

4. It is very largely the transportation service functions of aviation which represent its important economic role. Obviously, the scheduled air-
lines are the prominent aspect of air transportation, and the magnitude of their service to the state is indicated by the following statistics of 1960:

Michigan Airports Served	25
Total Movements of Scheduled Aircraft at Airline Airports	282,000
Revenue Passengers Originating	1,870,000 persons
Air Cargo Originating	34,000 tons
Air Mail Originating	4,670 tons
Total Revenue in Michigan	\$53 million (estimate)

5. Not widely recognized by the public is the even larger air transporta-
tion service performed by general aviation in cross-country or itinerant
flying. The use of planes by business to supplement airline schedule and to
reach communities served by indirect airline routes or not at all, is the
largest single generator of such traffic. Charter and air-taxi operations
by commercial operators and cross-country hops by private, pleasure aircraft
swell the total operations to impressive magnitude.

A measure of general aviation is indicated in the following table. The
data, it is to be noted, is for 1958, the year covered by the comprehensive
Transportation Institute survey.

General Aviation in Michigan

<u>Category</u>	<u>Active Aircraft</u>	<u>Flying Hours</u>	<u>Percent</u>
Business-Executive	549	164,100	36.7
Commercial-Industrial	288	56,900	12.7
Instructional-Training	269	87,600	19.6
Pleasure-Private	<u>1,706</u>	<u>138,600</u>	<u>31.0</u>
	2,812	447,200	100.0

6. Of this total activity, it is estimated that some 55% of the total flying hours, or roughly 230,000 in 1958, in general aviation were producing transportation, and the proportion is increasing.

Virtually all business flying is for the purpose of moving people or goods from one point to another. More than one-half of the commercial flying hours are devoted to air-taxi and charter service, and an increasing portion of pleasure flying—now about 20%—is itinerant or "cross-country." Only instructional and training flights are predominantly local and confined to a single airport or landing strip.

7. The economic aspect of general aviation is revealed by the data secured in the survey on 1958 investment and expenditure.

<u>Category</u>	<u>Investment</u>		<u>Expenditure</u>	
	<u>\$</u>	<u>Percent</u>	<u>\$</u>	<u>Percent</u>
Business	\$27,038,000	61.7	\$10,700,000	71.3
Commercial	8,236,000	18.8	1,950,000	12.9
Instructional	1,587,000	3.5	749,000	5.0
Pleasure	<u>7,029,000</u>	<u>16.0</u>	<u>1,635,000</u>	<u>10.8</u>
	\$43,890,000	100.0	\$15,034,000	100.0

Up-dating of these figures, in the continued absence of any regularly collected records, is possible only by periodic surveys such as that conducted as a part of this survey.

8. At least \$12 million of the total 1958 expenditures on general aviation were related to air transportation, and only \$3 million to local aviation in the State. From the planning standpoint, this increasingly important phase requires a transfer of attention to the system aspect of airports, because every transportation flight involves two or more locations—an originating airport and one at the destination as the very minimum.

As the highway traffic growth has so abundantly demonstrated, a comprehensive and coordinated network of facilities, rather than isolated improvements, stimulates transportation use. Air transportation flights can be expected to be generated to the degree that adequate destination airports become more widely established—the itinerant flyer must have reasonable assurance in advance that he will find satisfactory landing conditions and necessary services, including communication, as motivation for his flight.

9. The system concept of airports, imposed by the expanding transportation aspect of all civil aviation, demands a broader comprehension of need than has previously existed. The state and regional, as well as national, viewpoint replaces the traditional local approach to airport planning and support. Local initiative and resources are ordinarily too limited, even in many metropolitan urban areas, to afford the extensive planning and development of aviation facilities consistent with system requirements.

10. Air transportation, both airline and general aviation, produces numerous benefits which justify continuing expansion of the public investment in ground facilities—chiefly airports—but which are so widely diffused that they are directly felt by few citizens. Aviation, except for some of the newer military features, has rapidly shifted from a "gee whiz" to a "so what" regard in the public mind so that it is difficult to arouse and sustain for long the necessary support in any local area. Thus, it is concluded that aviation has reached the stage where the state government—the Michigan Department of Aeronautics and the State Legislature—must assume principal responsibility for airport expansion and coordinate, as well as lead, local efforts to secure a more useful air transportation system.

11. To facilitate the necessary planning, which is still severely handicapped by the continuing inadequate knowledge of economic relationships among aviation activities and community development, it is strongly recommended that an Economic Research Office be organized in the Michigan Department of Aeronautics. This office would undertake the regular collection, recording and analysis of significant statistical data, and maintain close liaison with other state agencies, such as the Economic Development Commission, where air transportation demands or needs can be ascertained.

The provision of an airport, an improvement, or a revision of air service can well be vital factors in the current and future competition among the states for economic growth. Such an Economic Research unit can be invaluable in alerting the State of Michigan to critical situations requiring immediate attention, and in providing a continuing source of information for more ef-

fective aviation planning for the future.

12. Until more accurate and objective data can be developed and as a specific framework around which the activities of such an office can be organized, a subjectively derived master plan for Michigan airport development is desirable. Utilizing the fragmentary economic facts now available and assuming certain broad interrelationships, it is possible to produce such a plan for the potential improvement of Michigan's air transportation and consequent economic gains to the local communities and to the State. It must be recognized that such a plan at this stage can only be general and tentative, with modification and elaboration as better understanding is achieved.

B. Technological Prospects

In developing a plan for Michigan aviation, the prospects for technological changes in aircraft and their utilization must be considered along with transportation planning factors. To assess the significant technical developments in aviation, Dr. Harold E. Allen of the University's Department of Aeronautical and Astronautical Engineering prepared Part III, Section I, of the Final Report, in which the trends in aircraft, air traffic, and traffic control are discussed in depth. The important conclusions are summarized in the following paragraphs.

1. The civilian aviation fleet, which will utilize the ground facilities being planned, will continue to be made up largely of conventional, propeller-driven, fixed-wing aircraft, including many now in use. No radical changes

in aircraft are expected to make present airport designs obsolete within the next ten to fifteen years.

2. Jet and "turbo-prop" aircraft will predominate in the scheduled airline fleets. Jets will be used by the trunk carriers in medium and long-haul service at the large and medium hub airports. The larger passenger capacity (100 or more seems a typical size trend) and high operating costs will tend to limit the number of airports served by trunk carriers; in Michigan, it is unlikely that jet airliners will serve more than two or three airports outside of Detroit Metropolitan Area because economic passenger loads cannot be developed. The spacing of major airport facilities is likely to be increased.

3. Even with intensified research and development efforts underwritten by the U.S. Government, it will be several years before any "supersonic" transport plane is ready. By 1975, it is now generally thought, it will be practical only for trans-ocean and trans-continental flights joining a very small number of very large airports. Prospects are unlikely that any Michigan airport will need to accommodate "supersonic" aircraft within fifteen years.

4. Turbo-prop aircraft in smaller sizes will be in general use by the local service airlines which provide commercial air transportation to all of Michigan, and exclusively to the northern half of the State.

5. The up-grading of the air transport fleets with the jet and "turbo-prop" aircraft is releasing some piston-driven, propeller-type aircraft at economical prices to the business-executive category of general aviation.

Thus, there is expected to be some increase in multi-engine, heavier aircraft in general aviation which will impose higher airport standards at those locations where "Business" class airports are indicated.

6. Similarly, it may be anticipated that the commercial category of general aviation will, by 1965, include more of the heavier planes with an increasing number of turbine-powered aircraft. These will be used principally in air taxi and charter service, while the other commercial operations will rely mainly upon existing types of conventional planes. The effect will be some widening in demand for airports adequate to handle multi-engine and single-engine, three place and over, aircraft.

7. For pleasure flying where single-engine, one and two-place planes predominate, it is expected that turbine-powered aircraft will become economically available. In the period 1965-70, there are reasons to feel that many older, piston-engine planes will be retired and that the fleet will be expanded with modern light aircraft as industry competition and improved buying power by younger men stimulates sales. More and better planes will, in turn, generate demands for the up-grading of airport facilities serving the private flyer.

8. Contrary to widespread popular impression, it is not felt that the helicopter or other VTOL (Vertical Take-Off and Landing) aircraft will generally replace conventional planes, either in scheduled airline or general aviation service. Despite the technical progress which has achieved greater reliability, higher speeds, and greatly increased passenger capacity, the operating costs of VTOL aircraft, including the helicopter, have not been

dramatically reduced to provide the long-promised "break through" and the basis for radical revision of airport planning.

On the evidence of the rate of progress, it now seems most likely that helicopter operations which justify heliports alone, will be confined to metropolitan feeder routes to the major Detroit airport. Heliports were properly included in the SEMMA plan for Detroit, but no other community in Michigan seems likely to develop sufficient traffic potential within the next ten years to justify this type of airport for any exclusive air-taxi or "air bus" service.

Nor does it seem possible that the improvements in operating economics of VTOL Aircraft will bring aircraft-mile costs into competition with fixed-wing aircraft on local air-service routes in the fifty-to-two hundred-mile range typical of Michigan. Hence, it does not seem feasible to abandon or drastically modify airport design for fixed-wing transport in favor of the heliport. The helicopter can use a small area of a conventional airport; but a conventional plane cannot land safely on a heliport, so there would seem little prospect of any state-wide need for heliports as such.

9. Other types of aircraft of the STOL (Short Take-Off and Landing) type, or some compound form of tilt-wing, or rotor plane which combines the nearly vertical take-off and landing of the helicopter with the higher flight speeds of fixed-wing craft are in various stages of development, and several have been demonstrated for military use. While there is much uncertainty surrounding their progress, available indications are that no civilian models will be commercially available for roughly ten years. When such aircraft

come into general use, if ever, there will be opportunity for greatly reduced airport sizes; for the immediate future, until 1970-75, however, the existing planes will continue to operate and permit no extensive shrinkage of airport areas.

10. Numerous technological improvements are already appearing in existing types of aircraft and control systems which, by providing greater reliability and safety, will expand general utilization of aviation by individuals and small organizations. This in turn will extend the demand for airports available for year-round, day-and-night use; all-paved airport surfaces, lighting and landing aids, radio communication, round-the-clock attendance, snow removal provisions are features that will become virtually standard requirements for all but small, local airports within five years.

11. In the longer range, assuming that the present rate of technological change permits introduction of "supersonic" and advanced jet-types of commercial airline aircraft along with V/STOL ("steep gradient") machines for local distribution of passengers and cargo, the period 1970-75 may well see a drastic revision of facilities. A very few, large airports for the long-haul, "super" planes and a large number of surrounding heliports, or short (under 1000 feet) fields as feeders may prove to be the new pattern.

12. To keep abreast of these technological changes and anticipate the far-reaching shifts which they may produce, it is recommended that the Department of Aeronautics assign continuing responsibility for such study and evaluation to a member of its engineering staff, and maintain close contact with any similar activity in the FAA. Only in such orderly manner can plans

be intelligently adjusted and inevitable technological obsolescence be efficiently accommodated.

C. Planning Approaches

Although the accomplishment of the desirable, objectively-derived, fully-detailed state-wide aviation plan must be further deferred until workable results of much more extensive research become available, it is now possible to work out the broad outline of such a plan. An approach, which should minimize later adjustments to more accurately determined needs, was devised and described in Part IV of the Final Report, "Planning for Michigan Aviation." The essential elements of that approach, and its supporting assumptions which are mainly developed in Part III, Section 2, of the Final Report, are summarized in the succeeding paragraphs of this portion of the Summary.

1. Assumptions inherent in this, and many other planning operations are predicated upon the following elements:

- (a) A continued population growth
- (b) A rising Gross National Product (GNP) in terms of "real dollars," not inflated values.
- (c) A high level of employment relative to the labor force (i.e., problems of "automation" and the like will be solved).
- (d) An increasing level of personal disposable income accruing to members of a rising aggregate number of consumer units having real annual incomes of \$5000 or more.
- (e) A further upward trend in individual leisure and vacation time.

These factors support projections of expanding commercial air transportation and general aviation for the U.S. as a whole.

2. For the State of Michigan, aviation projections were based heavily upon numerous State-Federal relationships rather than upon direct projections from current state and local levels. The lack of accurate records and the very short spans of time over which available records have been kept, do not permit statistically supportable trends within the state; far more confidence attaches to the national-state ratios for population and economic factors which are adequately based historically.

The resulting projections of Michigan aviation activities to 1975 are:

<u>Item</u>	<u>Number</u>	<u>Percent above 1960</u>
Airline Passengers	6,100,000 persons	228
Air Cargo	92,000 tons	171
Air Mail	9,700 tons	106
Airline Aircraft Movements	814,000 landings and take-offs	189
Active Civil Aircraft	4,450	58
Total Flying Hours	840,000 hours	57
General Aviation Movements	3,400,000 landings and take-offs	63

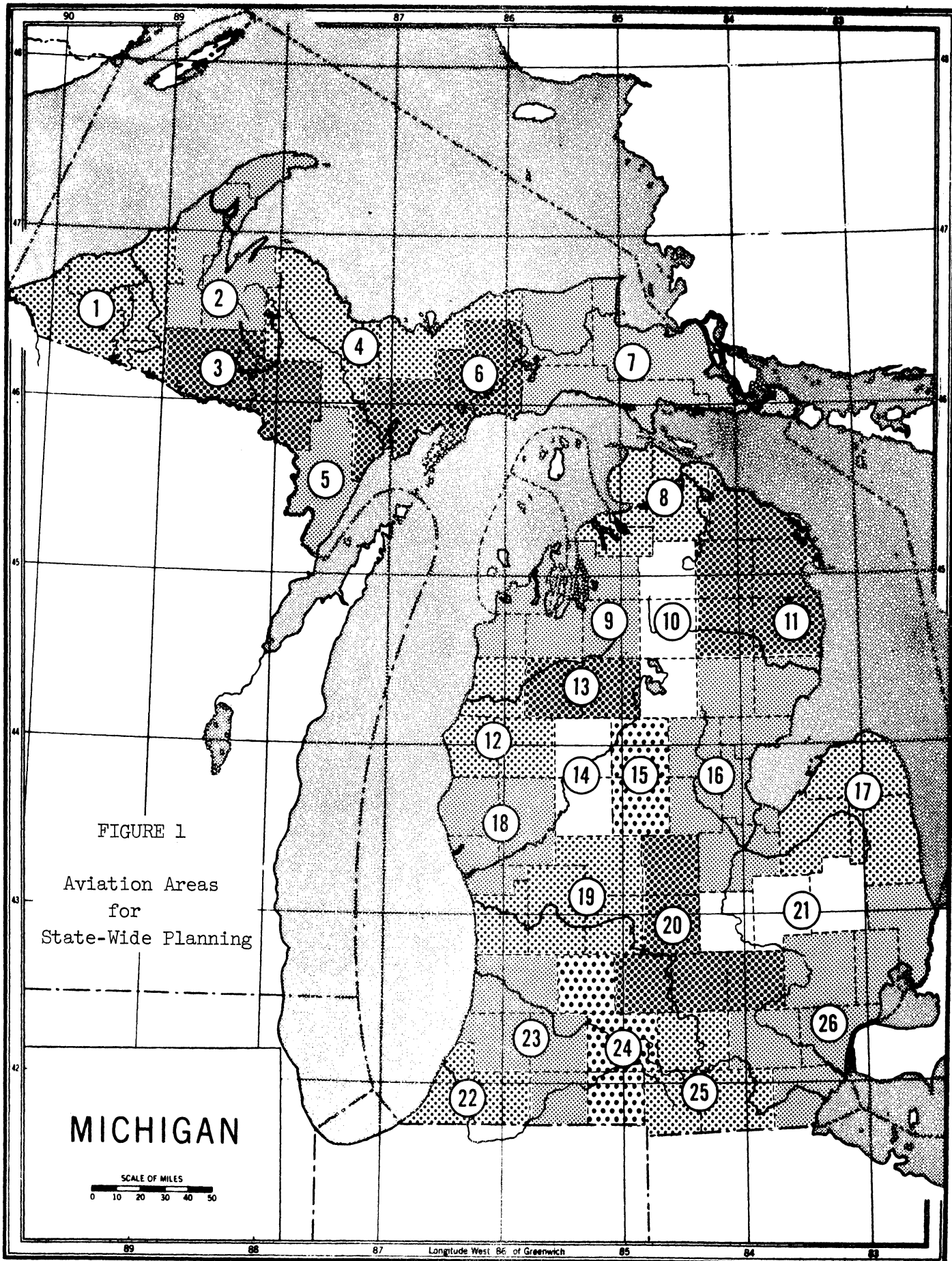
It is assumed, also, that early adjustment of the State's economy will offset currently adverse forces and that aviation growth from 1965 on will maintain a reasonably stable relationship to national growth.

3. These state figures must then be allocated to local areas in such manner that aviation needs can be measured and airport facilities to match can be specified. And it is at this stage that the prevailing ignorance of air transportation-community characteristic relationships, and lack of precise community data in many areas delay the objective planning process.

In part, it has been applied by dividing the state into so-called local areas of "Community aviation interest" and identifying the principal transportation determinants. Figure 1 shows the Aviation Areas as they were finally developed from studies of Michigan's geography, and highway traffic patterns which were considered major indicators of the significant transportation nuclei.

The only compromise in adjusting these areas was the definite assignment of the six counties of Area No. 26 to the Southeastern Michigan Metropolitan Area (SEMMA) for separate study outside of this project. Fortunately, the method subdividing the balance of the state, when the divisions were shifted to the county lines, substantially confirmed the somewhat arbitrary definition of the Detroit region.

4. These twenty-six areas were studied intensively to discover those characteristics significantly generating aviation activity, principally air transportation movements. Population and economic activities were indicated as critical and influential factors, but the almost complete lack of accurate air traffic records required indirect approaches to their aviation significance. Therefore, the subjective "Aviation Planning Classification" and "Current Growth Trend" ratings included in Table 1 were developed as guides.



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Table 1

MICHIGAN AVIATION PLANNING AREAS

Summary of Characteristics

Area No.	Principal Communities	Population 1960 Census	Percent of State Total	Michigan Registered Aircraft, 1960	Airports and Landing Fields, 1960	Planning Classification (See Note)	Current Growth Trend
1	Ironwood-Ontonagon	34,954	0.4	7	3	RRA	Declining
2	Houghton-Hancock-L'Anse	45,222	0.6	7	4	RRA	Declining
3	Iron Mountain-Kingsford-Iron River	41,101	0.5	13	5	RRA	Declining
4	Marquette-Ispeming-Munising	65,404	0.8	12	4	RIAR	Rising
5	Menominee	24,685	0.3	5	1	RRA	Static
6	Escanaba-Gladstone-Manistique	43,251	0.6	17	4	RRA	Static
7	Sault Ste. Marie-St. Ignace-Newberry	51,335	0.7	25	8	RIAR	Rising
8	Petoskey-Cheboygan-Charlevoix	43,875	0.6	36	9	RRA	Static
9	Traverse City-Frankfort	65,400	0.8	28	8	RIAR	Rising
10	Grayling-Gaylord-Houghton Lake	19,716	0.2	13	8	RRA	Rising
11	Alpena-Rogers City	55,896	0.7	32	12	RIAR	Rising
12	Ludington-Manistee-Baldwin	46,309	0.6	25	5	RIAR	Rising
13	Cadillac-Lake City	25,250	0.3	7	2	RRA	Declining
14	Big Rapids-Reed City	34,646	0.4	37	7	RRA	Rising
15	Mt. Pleasant-Clare	46,995	0.6	39	5	RIAR	Rising
16	Saginaw-Bay City-Midland	396,058	5.1	118	13	UIC	Rising
17	Caro-Bad Axe-Sandusky	109,625	1.4	78	8	BRU	Rising
18	Muskegon-Fremont	190,690	2.4	79	8	BRU	Rising
19	Grand Rapids-Holland-Greenville	540,833	6.9	187	12	UIC	Rising
20	Lansing-Alma-Howell-Charlotte	374,174	4.8	194	15	UIC	Rising
21	Flint Owosso-Lapeer	469,685	6.0	207	7	UIC	Rising
22	Benton Harbor-St. Joseph-Niles	186,797	2.4	94	4	BRU	Rising
23	Kalamazoo-Allegan-Sturgis	318,168	4.5	190	14	UIC	Rising
24	Battle Creek-Hastings-Coldwater	205,499	2.6	112	4	BRU	Rising
25	Jackson-Hillsdale-Adrian	244,525	3.1	158	10	BRU	Rising
26	Detroit-Pontiac-Port Huron-Ann Arbor	4,143,121	52.7	1,403	32	UIC	Rising
	STATE TOTALS	7,823,194	100.0	3,122	212	---	Rising

Note: Planning Classification for purposes of this study:

RRA - Rural, Agricultural, Recreational Area without vigorous main industry.

RIAR - Rural, Industrial, Agricultural, Recreational Area having at least one industrial concentration (mining, manufacturing, etc.).

BRU - Balanced, Rural-Urban Area with distributed activities and population.

UIC - Urban, Industrial Commercial Area with at least one major city and census classification as metropolitan area.

Growth Trend is rough estimate based upon population trend, employment and retail sales data.

5. Airport facilities in the aviation planning areas were also studied with the exception of Area No. 26, Detroit Metropolitan Area. This area, which is obviously the most important because of its overwhelming magnitude relative to the rest of the state, was the subject of a special study, not a part of this project, and was separately reported upon by Landrum and Brown in "Air Transportation Requirements of the Southeastern Michigan Metropolitan Area." The findings of that report have been consolidated with the data from the other twenty-five areas to develop the state-wide picture of airport facilities tabulated in Table 2. These were further reviewed to determine type of runway surface, lighting, radio facilities, and other features contributing to their adequacy.

6. Further consideration to adequacy was given by attempting to develop a standard of current and future demand as the geographic location, population, and resources indicated a demand for air transportation, either by commercial airlines or by general aviation, and for local flying. For airline service, the trend in passengers originating was reviewed in so far as records could be determined, and the testimony in the Great Lakes Service Case was given to the attractions of the various areas as they might generate cross-country flights.

The sharp division of the State between the concentrated population and industry in the southern areas and the sparsely populated "Water Wonderland" to the north produces a travel potential of strong proportions. Further, the concentration of small industrial developments based upon natural resources in relatively isolated areas is another potential for business-executive flights.

Table 2

MICHIGAN AIRPORTS AND LANDING FIELDS
By Length of Longest Runway (1960)

Area No.	Number of Airports Having Longest Runways (in feet)								Total	Notes
	Under 2500	2501-3200	3201-4200	4201-6000	6001-7500	Over 7501	Total	Notes		
1	1	1	1	---	---	---	---	3		
2	1	1	1	1	---	---	---	4		
3	3	---	2	---	---	---	---	5		
4	1	1	1	1	---	---	---	4		
5	---	---	1	---	---	---	---	1		
6	1	1	1	1	---	---	---	4		
7	2	6	---	---	---	---	---	8	Airline using military field temp.	
8	4	3	1	1	1	1	1	9		
9	1	5	1	1	---	---	---	8		
10	1	3	3	1	---	---	---	8		
11	6	5	---	---	1	---	---	12		
12	2	2	1	---	---	---	---	5		
13	---	1	1	---	---	---	---	2		
14	5	1	---	1	---	---	---	7		
15	1	2	1	1	---	---	---	5		
16	3	6	3	1	---	---	---	13		
17	6	2	---	---	---	---	---	8		
18	2	4	1	1	---	---	---	8		
19	5	6	---	---	1	---	---	12		
20	10	4	---	---	---	---	---	15		
21	2	3	1	1	---	---	---	7		
22	1	1	1	1	---	---	---	4		
23	6	6	2	---	---	---	---	14		
24	---	2	1	---	---	---	---	4		
25	4	4	1	1	1	---	---	10		
26	14	12	3	1	1	1	1	32		
Totals	82	82	28	16	2	2	2	212		

Considering all of the factors and giving due regard to the basis for the FAA National Airport Plan, six classes of airports were established for judging the general adequacy setting the requirements for minimum standards of airports in this approach to a Michigan aviation plan.

7. These six classes may be described as follows:

Class I. Major Air Hub Airport serving long non-stop jet flights in Continental and Intercontinental service and requiring runways longer than 7501 feet, as well as all supporting facilities—a major air terminal.

Class II. Medium and Small Hub Airport serving turbo-prop and new medium-range jets on Trunkline routes, and also serving heavier aircraft in business-executive flying as well as other general aviation. Runway lengths of 6001-7500 feet indicated with complete terminal facilities but in smaller scale than Class I.

Class III. Non-Hub Airport serving turbo-prop and propeller driven aircraft in Local airline service on short hauls, and also serving all but the very largest business aircraft. Runway lengths of 4201-6000 feet are indicated, along with minimum terminal facilities for passengers, cargo, and communications.

Class IV. Business airport for general aviation use by aircraft over 12,500 pounds maximum weight, and serving intercity business flights in some volume. Runway lengths of 3201-4300 feet are indicated, with terminal services approximating those of class III, except for airline accommodations.

Class V. Community (not to be confused with FAA "Commercial" designation) airport for general aviation use predominantly by aircraft weighing less than 12,500 pounds, serving some itinerant flights as well as a major volume of local traffic. Runway lengths up to 3200 are indicated, along with airport services dictated by local conditions.

Class VI. Special Service landing field or airport for use by light planes and requiring not over 2500 feet of runway.

All but the Class VI airports require at least one paved runway, lighting for landings and take-offs after dark, proper clear-zone approaches, and radio communication facilities. The geographic location with respect to the local area and the highway connections for surface transportation are also important considerations.

It is obvious that the higher classes will accommodate all traffic of lower classes with possible exception of Class I where heavy airline traffic of jet planes will discourage general aviation operations.

8. To make possible the precise engineering application of these standards, much more information about air traffic characteristics and demands must be developed than now exists. It is recommended, therefore, that the Department of Aeronautics initiate a series of surveys to determine more accurately patterns of aircraft use.

As a first step in such surveys, it should be possible to collect additional information as a part of the aircraft registration procedure. While it is realized that there are difficulties, it is felt that these can be overcome through carefully devised forms and firm insistence upon their completion; since slightly over 3000 planes are involved, the paper work need not be overwhelming.

A second step could be the establishment of periodic origin-and-destination surveys at selected airports. Commercial airline passengers, as well as general aviation flights, should be included to give a clearer picture of

the airport zone of influence as well as the air traffic pattern. The co-operation of local airport personnel might be possible, but it is anticipated that Department personnel would perform the major role in planning and supervising such surveys, analyzing them, and maintaining records for planning purposes.

Until such information is available, the planning purposes cannot be fully realized.

D. A Proposed Airport Plan for Michigan

Utilizing the available information, which has been developed in the various sections of the Final Report, and applying the system concept of airport development whereby inter-airport relationships become more important than based-aircraft alone, the aviation pattern of the State has been subjectively reviewed. Trends in area growth, and the influences of particular area characteristics and resources have been taken into account to visualize the possible requirements to 1970—ten years in the future. These are delineated upon the maps, Figures 2a and 2b, which show the minimum anticipated airport locations essential to serve civil aviation, but omitting the detail for the Detroit Metropolitan Area which has been separately treated.

Table 3 supplements the map by indicating the particular class of airport which probably will be required, and notes the justification for the particular type. Obviously, this justification could be developed at length for each airport, but the elaboration is purposely omitted at this stage to maintain emphasis on the scope of the plan.

Table 3

PROPOSED MICHIGAN AIRPORT SYSTEM, 1961-70

<u>Area No.</u>	<u>Location</u>	<u>Class</u>	<u>Justification</u>
1	Ironwood	III	Local Airline Service
	Ontonagon	IV	Business-Industrial Development
2	Hancock-Houghton	III	Local Airline Service
	L'Anse-Baraga	V	Community-General Use
3	Iron Mountain	III	Local Airline Service
	Crystal Falls-Iron River	V	Community-General Use
4	Marquette	II	Trunk Airline Service
	Munising	V	Community-General Use
	Grand Marais	VI	Special-Access
5	Menominee	III	Local Airline Service
6	Escanaba	III	Local Airline Service
	Manistique	V	Community-General Use
7	Sault Ste. Marie	II	Trunk Airline Service
	St. Ignace	IV	Business-Commerical
	Newberry	V	Community-General Use
	Bois Blanc Island	VI	Special-Access
	Drummond Island	VI	Special-Access
	Mackinac Island	VI	Special-Access
8	Pellston	III	Local Airline Service
	Cheboygan	IV	Business-Commercial
	Beaver Island	V	Community-General Use
	Boyne City	V	Community-General Use
	Charlevoix	V	Community-General Use
9	Traverse City	III	Local Airline Service
	Frankfort	V	Community-General Use
	Bellaire	VI	Special-Access
	Interlochen	VI	Special-Educational Institution
	Kalkaska	VI	Special-Access
	Northport	VI	Special-Access
10	Gaylord	IV	Business-Commercial
	Grayling	IV	Business-Military
	Houghton Lake	V	Community-General Use

<u>Area No.</u>	<u>Location</u>	<u>Class</u>	<u>Justification</u>
11	Alpena	III	Local Airline Service
	Rogers City	IV	Business-Industrial
	Atlanta	VI	Special-Access
	Harrisville	VI	Special-Access
	Mio	VI	Special-Access
12	Manistee	III	Local Airline Service
	Ludington	IV	Business-Industrial
	Baldwin	VI	Special-Access
13	Cadillac	IV	Business-Industrial Development
14	Reed City	III	Local Airline Service
	Big Rapids	IV	Business-Educational Institution
15	Mt. Pleasant	IV	Business-Educational Institution
	Clare	V	Community-General Use
16	Tri City-Saginaw	II	Trunk Airline Service
	Bay City	IV	Business-Industrial
	Midland	IV	Business-Industrial
	Saginaw	IV	Business-Industrial
	Tawas	IV	Business-Military Base
	Gladwin	V	Community-General Use
	West Branch	VI	Special-Access
17	Bad Axe	IV	Business-Industrial Development
	Caro	V	Community-General Use
	Sandusky	V	Community-General Use
18	Muskegon	II	Trunk Air Service
	Fremont	IV	Business-Industrial
	Hart-Shelby	V	Community-General Use
19	Grand Rapids	II	Trunk Air Service
	Greenville	IV	Business-Industrial
	Grand Haven	V	Community-General Use
	Holland	V	Community-General Use
	Ionia	V	Community-General Use
20	Lansing	II	Trunk Air Service
	Alma-St. Louis	IV	Business-Industrial
	Charlotte	V	Community-General Use
	Howell	V	Community-General Use
	Brighton	VI	Special-Based Personal Planes
	East Lansing	VI	Special-Instructional

<u>Area No.</u>	<u>Location</u>	<u>Class</u>	<u>Justification</u>
21	Flint	II	Trunk Air Service
	Lapeer	IV	Business-Industrial
	Owosso	IV	Business-Industrial
	Mt. Morris	VI	Special-Based Personal Planes
22	Benton Harbor-St. Joseph	III	Local Airline Service
	Niles	IV	Business-Industrial
	Dowagiac-Cassopolis	VI	Community-General Use
	New Buffalo	VI	Special-Access
	Watervliet	VI	Special-Based Personal Planes
23	Kalamazoo	III	Local Airline Service
	Allegan	IV	Business-Industrial
	Three Rivers	IV	Business-Industrial
	South Haven	V	Community-General Use
	Sturgis	V	Community-General Use
	Wayland	VI	Special-Based Personal Planes
24	Battle Creek	III	Local Airline Service
	Coldwater	IV	Business-Industrial
	Marshall-Albion	IV	Business-Industrial
	Hastings	V	Community-General Use
25	Jackson	III	Local Airline Service
	Adrian-Tecumseh	IV	Business-Industrial
	Tecumseh-Adrian	V	Community-General Use
	Hillsdale	V	Community-General Use
	Brooklyn-Napoleon	VI	Special-Based Personal Planes
26	See Landrum and Brown Report		
	Detroit Metropolitan	I	1
	Willow Run-Auxiliary to Metro.	II	1
	Detroit City	III	
	Pontiac		
	Port Huron		3
	IV	2	
	V	7	
	VI	11	

Table 4 recapitulates the recommendations of the map and of Table 3 to show the number of airports of each type. The number from the Detroit Metropolitan Area is included under each heading on the basis of translation of the Landrum and Brown recommendations to the classification used in the University study. On the whole, it is considered a reasonably balanced system of airports for a geographic area as varied and extended as that of Michigan.

It is not intended that the proposed plan be a rigid guide which is to be followed without deviation. Instead, it is a broad outline which will demand carefully detailed studies of existing airports, the suggested service requirements, actual traffic developments, and of the best engineering and economic solution to the air transportation problems of each area. Even the indicated locations are not necessarily final, because some will inevitably prove undesirable; some locations may not in final analysis justify the class now indicated, or even any facility, while others undoubtedly will develop additional needs.

Nevertheless, it is firmly believed that these 118 airports will, with minor revisions, provide the basic air transportation facilities essential to the growth of the State's economy through 1970.

The populated areas of the State having communities of 10,000 or more persons are directly served by airline airports, or are within twenty-five miles or forty-five minutes driving time of such facilities as shown in Figure 2b (air service to such airports is, it may be remarked, outside the jurisdiction of the State and in the hands of the CAB; but without adequate

Table 4

SUMMARY OF AIRPORT TYPES, 1961-70

<u>Class</u>	<u>Type</u>	<u>No. in Plan</u>
I	Intercontinental (Jet)	1
II	Trunkline Air Carrier	8
III	Local Service Airline	17
IV	Business	28
V	Community	33
VI	Special Purpose	<u>31</u>
Total		118

airports, there could be no service, anyway.) Those areas actively generating business flights, or promising industrial development which will create such demand, are either directly served or are within fifteen miles or twenty-five minutes driving time of an adequate airport. And, smaller cities and areas of resort and vacation attractions are provided with the airports essential to the maintenance of general aviation traffic.

As 1970 is approached, technological changes in aircraft as well as shifts in the State's population and economic activities suggest new approaches to the state-wide plan. It may be desirable then to consider much more seriously the concentration of airline traffic at regional airports from which the local areas can be served by steep-gradient (V/STOL) aircraft operating to very small heliport-type fields. At this early date, however, this can only be speculation and not the basis for any reasonable plan.

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